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AUTHOR Tuan, Hsiao-lin; Chang, Huey-Por; Wang, Kuo-Hua; Treagust, David F.

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ABSTRACT

This study compares the results of Australian and Taiwanese Grade 10 students (N=2959) on the Students' Perceptions of Teacher Knowledge (SPOTK) questionnaire. The purposes of this paper are to quantitatively compare the mean scores of each item in the two countries and to use qualitative research methods involving classroom observations and interviews of students (N=64) to gain insight into students' reasons for their responses to the questionnaire. Interviews are based on questionnaire items that showed statistically significant differences in scores between Taiwan and Australia. Findings indicate that Taiwanese teachers prefer using verbal illustrations to teach science concepts, provide less help to students in extending their science learning to daily life, concentrate on scientific theories and principles, constantly monitor students' learning, and reinforce students' memorization and calculating ability more than the Australian science teachers. Contains 19 references. (DDR)

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Hsiao-lin Tuan, Huey-Por Chang, Kuo-Hua Wang,
National Changhua University of Education, Taiwan

David F. Treagust
Curtin University of Technology, Australia

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Hsiao-lin Tuan, Huey-Por Chang, Kuo-Hua Wang,
National Changhua University of Education, Taiwan

David F. Treagust
Curtin University of Technology, Australia

SUMMARY

The development of students questionnaire for assessing teachers' pedagogical knowledge went through several iterations, with different aspects of Shulman's (1987) categories being combined because they were not clearly distinct to students. The final four dimensions of the new instrument, referred to as *Students' Perceptions of Teachers' Knowledge* questionnaire (SPOTK) are Instructional Repertoire, Representational Repertoire, Subject Matter Knowledge, and Knowledge of How to Assess Students' Understanding.

In total, 1879 students from 50 classes in Taiwan and 1080 students from 50 classes in Western Australia were administered the Teacher Knowledge Questionnaire. The final 28-item instrument with validity and reliability measures at an acceptable level is discussed by Tuan, Chang, Wang, & Treagust (1997).

The purposes of this paper were to quantitatively compare the mean scores of each item in the two countries and to use qualitative research methods involving classroom observations and interviews of students to gain insight into students' reasons for their responses to the questionnaire. Thirty six Taiwanese students and 28 Australian students were interviewed based on items in the questionnaire which showed statistically significant differences in scores between Taiwan and Australia, and/or which the researchers considered relevant to the study in terms of the culture and expectations of schooling.

Findings of the study indicated that differences in the scales means between the two countries were largest for Representational Repertoire (RR) and Knowledge of Student Understanding (KSU), both of which students in Taiwan perceived more favorably. The comparison of students' perceptions of the teachers' pedagogical knowledge between the two countries indicated that in Taiwan, science teachers showed more preference in using verbal illustrations to teach science concepts, provided less help for students to extend their science learning from classroom to daily life, concentrated on science theories and principles, constantly monitored students' learning, and reinforced students' memorization and calculating ability more than Australian science teachers. Both Taiwanese and Australian students showed their trust in teachers' subject matter competence, however. Factors influencing science teachers' teaching differently in the two countries were the size of the physical setting, the materials that teacher and students used in the classroom, and the different expectations of the teachers' role in Taiwan and Australia.

INTRODUCTION

Many researchers (Fraser, Rennie, & Tobin, 1990; Tobin & Fraser, 1989; Tobin, Kahle, & Fraser, 1990) revealed that teachers' metaphors of their roles and their content knowledge influenced students' perception of the classroom learning environment. In other words, teachers' knowledge influenced the learning environment they generated. In fact, when teachers construct their knowledge on teaching, the construction processes are influenced by their personal experiences and the situations and cultural context in which they are involved. On the other hand, science teachers must reconstruct their understanding of subject matter knowledge, and then transfer this knowledge in a way meaningful to their students (Shulman, 1986, 1987). This kind of knowledge representation would be influenced on the classroom context, students' characteristic, and the educational culture which influenced the classroom context (Cochran, DeRuiter, & King, 1993; McDiarmid, Ball & Anderson, 1989;Tobin, Tippins & Gallard, 1994).

The importance of looking at science learning from cultural perspectives has been advocated by many researchers (Aikenhead, 1996, 1997; Allen, 1998; Cobern & Aikenhead, 1998; Kawasaki, 1996; Lynch, 1995, 1996). Basically, these researchers treated science as a subculture, thus learning science is to help students to transmission subculture science into their existing daily life culture. Thus students' own culture would influenced the way teachers' teach and the degree of acceptance of the science culture. As Cobern and Aikenhead (1998) explained that the terms culture used in these studies were

> 'an ordered system of meaning and symbols, in terms of which social interaction takes place' (Geertz, 1973, p.5), others were communication, social structures, skills, customs, norms, attitudes, values, beliefs, expectations, cognition, conventional actions, material artifacts, technological know-how and worldview. (p.3)

As all people live and grow up in their own culture, we can infer that a science teacher's knowledge on teaching is also influenced by his or her understanding of the nature of science, the school culture and societal culture. However, as we live in our own culture for a long period of time, we almost forget how our beliefs, expectations of science learning and teaching have influenced the way teachers teach in the classroom. Thus, a comparison study could help us discover how culture influences students' perceptions of science teachers' knowledge. The purpose of conducting cross-culture comparison study is not to compare or contrast the difference between teachers' knowledge in two cultures, but to gain a better understanding of how culture influences our own students' perceptions toward science teachers' teaching in the classroom. Hopefully, by this kind of comparison we can make future improvements which match our own culture instead of simply importing other countries' teaching methods in one own school.

PURPOSE OF THE STUDY

In accordance with the kinds of teachers' knowledge advocated by Shulman (1987), Tuan, Chang, Wang and Treagust (1997) developed a students' questionnaire for assessing teachers' pedagogical knowledge. This questionnaire went through several iterations, with different aspects of Shulman's (1987) categories being combined because they were not clearly distinct to students. The final four dimensions of the new instrument, referred to as *Students' Perceptions of Teachers' Knowledge* questionnaire (SPOTK) are Instructional Repertoire, Representational Repertoire, Subject Matter Knowledge, and Knowledge of How to Assess Students'

Understanding. The goals of this study are to combine both qualitative and quantitative research method to compare and to understand the difference students' perceptions of teachers' knowledge in the above four categories in Taiwan and Australia. The combination of qualitative and quantitative method together were advocated by Fraser & Tobin (1991) and Fraser (1996). The reason in using both qualitative and quantitative research methods is to use quantitative research to portray the landscape of the difference of teachers' teaching in two countries, and use qualitative research to explore deeper understanding on how culture influence the difference between two countries' students' conceptions of their science teachers' teaching in two countries.

RESEARCH METHODS

The development of Students' Perceptions of Teachers' Knowledge questionnaire (SPOTK) provided a highly valid and reliable questionnaire (Tuan, Chang, Wang, Treagust, 1997). The reliability (Cronbach alpha coefficient) of each scale, using the class mean as the unit of analysis, ranged between 0.94 and 0.97 in both Australia and Taiwan. Factor analysis generally supported the four-factor a priori structure in both Taiwan and Australia. The final 28-item version of the questionnaire was administered to a sample of 1081 grade 8 and 9 general science students from 50 classes in 25 schools in Western Australia and 1879 grade 7 to 9 students from 50 classes, half physical science and half biology science, in 25 schools in Taiwan. Of the 50 general science classes selected in Western Australia, 38 were selected from within the metropolitan areas of the capital city, Perth and the remaining 12 classes were from north, east, and south of Perth. The sample in Taiwan was selected from the northern Taiwan (Taipei), central Taiwan (Taichung), an southern Taiwan (Kaohsiung). The samples from both countries were drawn from public, coeducational schools that could be considered typical and representatives of science classes in each country. All the quantitative data were analyzed by T-test, the results of the findings were listed in Table I.

In the qualitative data collection, 36 eighth grade Taiwanese students enrolled in three beginning physical science teachers' classroom were selected for interview. The selection criteria for the interview were the students who scored the highest, middle and bottom rank level in each scale. We chose two students per scale in each class, 36 students were selected for the interviews. All interviews were tape-recorded, and transcribed verbatim for analysis. Classroom observation of the three beginning science teachers' teaching were also collected by Taiwanese researchers to gain better insight of the students' interview responses.

In Western Australia, three Taiwanese researchers and one Australian researcher conducted five class observations of five science teachers in two public schools, followed by interviewed of a entire class of ninth grader students (20) in chemistry class. A further eight students from another school were extensively interviewed by the Australian researcher to ascertain their meaning of the terms used in the questionnaire.

Nine items were selected from the questionnaire which based on (1) the significant difference in scores between Australia and Taiwan; (2) items important to study in terms of culture, expectations of schooling, and our own interests; (3) items that did not meet the statistical validation criteria for retention in the questionnaires given to both groups. Finally there were 12 items selected for interview, three on each scales, and these are presented in Figure 1.

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71. My teacher divides the whole class into small groups for teaching activities (*being deleted item*).

72. My teacher's teaching methods keep me interested in science. (*interested to researcher*)

77. My teacher's teaching methods make me think hard. (*interested to researcher*)

80. My teacher uses familiar examples to explain scientific concepts.(*Statistic significant*)

81.My teacher uses appropriate diagrams and graphs to explain science concepts.(*interested to researcher*)

87. My teacher explains science concepts using language that I can understand.(*item be deleted)*

90.My teacher explains science concepts clearly.(*item to be deleted*)

93. My teacher knows the answers to questions that we ask about science concepts.(*item interested to researcher*)

96. My teacher explains the impact of science on society. (*item interested to researcher*)

99. My teacher's questions evaluate my understanding of a topic.(*statistically significant*)

100. My teacher's questions evaluate my understanding of a topic. (*statistically significant*)

103. My teacher assesses the extent to which I understand the topic.(*item interested to researcher*)

Figure 1. Items from the *Students' Perceptions of Teachers' Knowledge* questionnaire (SPOTK) with which students were interviewed.

All the qualitative data were analyzed in an analytic and inductive way. the findings were reported as assertions which combined with qualitative and quantitative evidence (Erickson, 1986; LeCompte & Preissle, 1993)

RESULTS

Quantitative Responses to categories

For the Instructional Repertoire category, the total mean responses for Taiwanese and Australian students was 26.40 and 26.17 ,respectively indicating that the events that these items were investigating occur between 'sometimes' and 'often' (3.30, 3.27)

For the Representational Repertoire category, the mean response for Taiwanese and Australian students was 25.19 and 23.54 respectively indicating that the events that these items were investigating occur between 'sometimes' and `often'(3.60, 3.36).

For the Subject Matter Knowledge category, the mean response for Taiwanese and Australian students was 23.73 and 23.52 respectively indicating that the events that these items were investigating occur 'often' (3.96, 3.92).

Table 1: The 2 tail T test between Taiwanese and Australian students' responses on SPOTK questionnaire

	Australia (n=50 classes)		Taiwan (n=50 classes)		
Item & Scale	Mean	SD	Mean	SD	T-value
IR scale	26.17	3.48	26.40	4.02	-.30
IR2	3.26	.59	3.52	.53	-2.22
IR3	3.40	.40	3.43	.49	-.34
IR4	3.30	.50	3.32	.57	-.18
IR5	3.22	.56	3.08	.59	1.38
IR6	3.21	.49	3.25	.63	-.35
IR7	3.29	.40	3.45	.51	-1.86
IR8	3.27	.44	3.25	.54	.22
IR9	3.22	.47	3.09	.55	1.28
RR scale	23.54	2.59	25.19	2.65	-3.11*
RR1	3.45	.39	3.88	.37	-5.75**
RR2	3.70	.37	3.78	.40	-.98
RR3	3.62	.45	3.58	.48	.45
RR4	3.43	.43	3.72	.42	-3.63**
RR5	2.89	.49	2.94	.50	-.48
RR6	3.18	.41	3.61	.41	-5.08**
RR7	3.27	.45	3.68	.40	-4.58**
SMK scale	23.52	2.19	23.73	1.74	-.50
SMK1	4.14	.41	4.21	.41	-.82
SMK3	3.95	.41	4.22	.34	-3.43**
SMK5	4.05	.40	4.17	.29	-1.59
SMK6	3.94	.37	3.98	.38	-.60
SMK7	3.84	.44	3.71	.33	1.65
SMK8	3.60	.42	3.45	.37	1.82
KSU scale	25.64	2.26	27.33	2.07	-4.21**
KSU1	3.69	.40	3.99	.33	-4.47**
KSU2	3.66	.35	3.91	.33	-4.19**
KSU3	3.65	.34	3.87	.34	-3.17**
KSU4	3.52	.39	3.76	.37	-3.26**
KSU6	3.56	.34	3.61	.41	-.61
KSU7	3.83	.36	4.19	.29	-6.29**
KSU8	3.72	.38	3.99	.32	-4.38**

Note: **p<.001, *p<.01

For the Knowledge of Student Understanding category, the mean response for Taiwanese and Australian students was 27.33 and 25.64, respectively indicating that the events that these items were investigating occur more toward 'often' (3.90, 3.66)

A two tail T-test was used to examine the mean score for the four categories and each item (see Table 1) indicate that there are some significant difference between the perceptions of Taiwanese and Australian students on their teachers' Representational Repertoire and Knowledge of Students' Understanding categories.

Items showing significant differences at the .001 level were: My teacher uses familiar examples to explain scientific concepts"; "My teacher uses stories to explain science ideas"; "My teacher uses familiar events to describe scientific concepts."; and "My teacher explains science concepts using language that I can understand." In other category "Teachers' Knowledge of Students' Understanding", there are some items such as "My

teacher's tests evaluate my understand of a topic", My teacher's questions evaluate my understand of a topic"; "My teacher's assessment methods evaluate my understanding"; "My teacher uses different approaches (questions, discussion, etc.) to find out whether I understand"; "My teacher uses tests to check that I understand what I have learned"; and "My teacher's tests allow me to check my understanding of concepts." showed significant differences at .001 level. In Teacher's Subject Matter Knowledge category, one item "My teacher knows how science theories or principles have been developed." showed a significant difference at .001 level. On all these items, Taiwanese students showed more preference on their teachers' teaching than did Australian students.

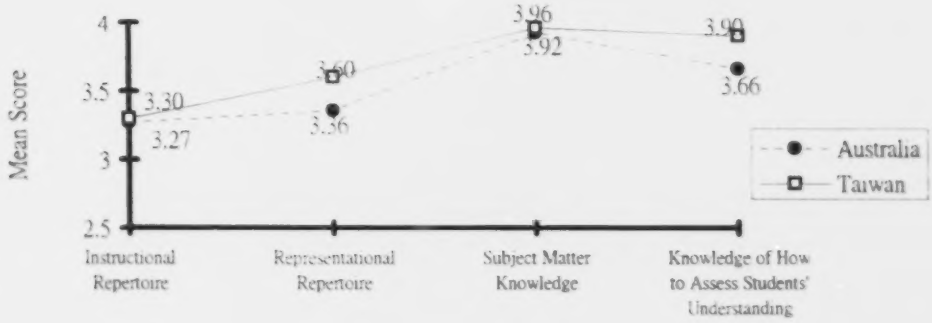

Figure 2 : Mean Scale Score for the SPOTK(using the class mean as the unit of analysis)

Findings from combining qualitative and quantitative data

1. Taiwanese science teachers showed more preference in using verbal illustrations to teach science concepts than did Australian science teachers.

In our classroom observations, we found out that most science teachers in Taiwan rely heavily on using verbal expression to teach science concepts. Lecture combined with notes taking, solving arithmetic problem, and lab activities were the main teaching activities conducted in the Taiwanese science classrooms. However, in the above various teaching activities, teacher always used verbal expression to dominate all the teaching activities. In Taiwan, science teachers did not design material or worksheets to use in the class, but their time were concentrated on organizing content information in the class. The classroom teaching was the major effort that Taiwanese science teachers pay attention to. In the class, most of time students were listening, taking notes, and working on problem solving exercises individually in the class. Students did not need to spend a lot of time in reading, but needed to pay attention on listening the teachers' lecture. All the quantitative data indicated that Taiwanese teachers used more verbal expression to describe and explain science concepts in teachers' representational repertoire than did Australian science teachers, these findings are also supported by our observational data.

On the other hand, Australian science teachers used various ways in conducting classroom activities instead of relying heavily on lecturing. In Australian science classes, we saw teachers would use worksheet, OHT,

group discussion, and lab activities in their teaching. All the worksheets and OHT were designed by Australian science teachers in their planning time. Thus, in the classroom, science teachers would introduce the science concepts, but they would also request students in spending time in reading, discussion and findings answer to fill in the worksheets in the classroom.

2. Australian science teaches would help students extend science learning from classroom to their daily life more than Taiwanese science teachers.

There are some items did not show significant difference but provide rich information for us to understand the difference between two cultures. These items are "My teacher uses appropriate models to help me understand science concepts"; "My teacher shows us activities that I can use to continue my study of a topic"; "My teacher knows the history behind science discoveries"; "My teacher explains the impact of science on society". Students' responses to these items showed that Australian science teachers made more frequent connections to science in daily life than did Taiwanese science teachers, which indicated that in Australia, learning science did not finish in class, it can be extended from the classroom to family life and to society.

Observations in the Australian science classes showed that one science teacher assigned students to construct a project on the fire-proved house. Students have to design a fire-proved house and then report in the class. When a teacher teaches Fire reporting topic, he gave students a worksheet which listed the fires causes in rural and outer metropolitan area from 1990 to 1992, then having students to work as a group to discuss from the table he gave to students. These topics did not show in Taiwanese textbook, nor did the kinds of homework or class-work teacher would assign students to work with.

In Taiwan, science teachers seemed to treat covering the topic on the textbook as the only goal in the classroom. In their classroom teaching, although teachers would mention how this topic could relate to students' daily life verbally, students did not think it is necessary to extend what they have learned in the classroom to their family and community. Interviews with Taiwanese students about whether teachers would give them activities that they can use to continue their study of a topic, many students responded that "Yes! My teachers would tell us we can try to conduct certain activities in my home, but he did not request us to do so."

When we interviewed students from both Taiwanese and Australian classrooms on the question "My teachers know how science is related to technology", many Taiwanese students asked us what is technology, which indicated that students did not know how science is related to technology. The relationship between science and technology was not addressed in the Taiwanese science textbook neither was it addressed in the teachers' teaching. But the importance of concept of technology and society was shown in the Australian science textbooks and in the teachers' teaching.

3. The goal of the science curriculum provided in the textbooks, among science teachers and students were different in Taiwan and Australian

In Taiwan, the curriculum goals are very specific to help students understand and master science concepts. The most important goal hold by science teachers was to help students understand and master science concepts in order to gain better achievement score in the examination, which could help them attend better high schools after their graduation in junior high school. Therefore the main feature in Taiwanese science teaching in the

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classroom is that they spent a lot of time explaining science concepts, using questions to monitor students' understanding and attention, conducting problem solving for students to practice their mastering of the science concepts taught in

However, in Australia, helping students master science concepts did not show during our observation and neither in our interviewed with the students. It seemed that learning science to Australian students were mainly to increase their scientific literacy and to help them to have a better life at home, instead of helping them attend a better high school or learn more science for the next level of study. Thus, when we interviewed Australian students, researchers and conduct classroom observation, we did not feel that mastering science concepts is so important in science teaching. Instead, science teachers seemed to help their students having more comprehension and discussion ability in the classroom. Students could response the worksheets from reading the textbook and discussion with their students, which indicated that they only needed to comprehend the content instead of memorize the concepts in the class.

As we interviewed the Australian science teachers, we found that they have many textbooks which can help them to design their lessons and worksheets. On the country, in Taiwan, we have centralized curriculum to follow, thus all science teachers teach the same topic covered in the textbooks. Most of the content cover in the textbook addressed on experiment and defining the science concepts. Few topics related to how science concepts related to daily life and society. There are some places in textbook where calculation were addressed in the textbook, such as calculate the mass of a reactant, and the final velocity of an moving object.

Again, these differences did not mean which country is better than the other, however, it showed how society expectations, textbooks and the education system influenced the ways that teachers teach in the science class.

4. Taiwanese science teachers showed more frequent monitoring of students' progress in the class than Australian science teachers. But the ways to monitor students' understanding were more limited in Taiwan than in Australia.

Based on Table 1, classroom observation and students' interview data, Taiwanese students perceived that their science teachers frequently asked questions, giving quizzes, and having school monthly examinations in the classes. These methods could assess students' understanding of the content knowledge. Some of the students expressed that "my teachers questions, or the tests could help me to assess my own understanding of the content covered in the topic". Students assess their own understanding based on the test results they got. On the other hand, teachers heavily rely on students' tests results to check students' understanding. Based on test results, teachers would know whether they needed to re-teach certain topic again.

In Australia, the quantitative data (Table 1) showed that teachers did not monitor students' understanding as frequently as did Taiwanese teachers, which were also supported by our observation and class interviews. One interesting phenomena showed in the questionnaire, that "my teachers used various assessment methods to check my understandings". In Taiwan, this means that teachers asked questions, using quiz and monthly examinations to assess students' understanding. However, in Australia, we often see students work together to finish the worksheets. Thus the worksheets activities provided not only as a learning activity but also as an evidence for teachers to monitor students' understanding. Teachers used more worksheets, homework, questions, and discussion to assess students' understanding instead of concentrating on giving quiz and school

examinations to assess students' understanding.

5 In science classes, Taiwanese science teachers reinforced students' memorization and calculation ability, however, Australian science teachers reinforced students' comprehension and writing ability.

In Australia, most of the worksheets were designed by science teachers mainly to assess students' comprehension ability. Independently, students need to read textbooks or the handouts disseminated by teachers, and were engaged in intensive writing to answer the questions in the worksheets. For instance, in the topic of fire reporting, a teacher put a table of fire reporting in the worksheets, and then listed the questions on the worksheets, such as "Explain why there is such a large difference between rural and metropolitan areas of fire causes?" "How many percentage of fires started by children in the outer metropolitan area in 1990/91, 1991/92?" What students needed to do is to read the table with their peers and then discuss the possible responses to the questions. Teachers used many of these worksheets in the class which automatically reinforced students' comprehension and writing ability in the science classes.

However, in Taiwan, many of the classrooms we observed did not use designed worksheets by teachers. Teachers would give students seat work by putting some calculation problems on the board, or asking the exercises problems listed in the textbook. Sometimes, teachers would ask students to finish commercial worksheets, which consisted of filling-in-the-blanks problems, multiple choice items, and calculation problems. Based on the nature of the worksheets, Taiwanese students seemed to practice memorization and calculating skills during these processes. However, in Australia, mastering the science concepts and applying them in calculating situations did not seem important compare with comprehension the concepts itself. Thus calculating exercise did not show often in the Australian science classrooms, instead reading and writing were showed more often in the class teaching.

6. Both Taiwanese and Australian students showed their trust in teachers' subject matter competence, however, Taiwanese students were more favorable in assessing their teachers' subject matter knowledge than Australian students.

Based on Table I, it revealed that both Taiwanese and Australian students gave high scores on teachers' subject matter knowledge. Most Taiwanese students interviewed on their perceptions of teachers' subject-matter knowledge responded "If he can stand in the classroom as a science teacher, I think he must have competence in his content knowledge." Students trust teachers' subject matter competence based on the title of "science teacher". It also illustrated that in Taiwanese culture, students and majority of the people trust and respect teachers who have a very high social status in the Taiwanese society. These cultural aspects influenced students not questioning whether their science teachers have competence in their subject matter knowledge or not. In addition, Taiwanese science teachers liked to provide more details to explain the science concepts that were taught and these are usually directly related to what have been covered in the textbook.

Australian science teachers rarely wrote notes on the blackboard but tended to give a general definition of the topic and then help students to discuss how this topic could related to other field or daily life events. With regards to the frequency of questions asked by students, Taiwanese students rarely asked questions in the class and almost always assumed that teachers could answer their questions. However, in Australia, teacher and

students have more frequent discussion on the topic, and students ask more questions than their Taiwanese counterparts. However, a problem arises in Australian classrooms when science teachers are teaching out of their subject area – as often happens in general science – and consequently do not have a strong competence in their content area and cannot easily respond to students' questions. The different classroom teaching atmosphere also influenced the way that these two countries of students' perceptions toward teachers' subject-matter knowledge.

7. Taiwanese students take a more responsible role for their own learning than do Australian students.

In Taiwan, as we interviewed students whether teachers can answer students' questions, most of students responded that they and their classmates asked few questions in the class. However, they still think teachers' subject matter competence could respond to students' questions. When we asked why did they not making good grade in their science courses, most of them would blame on their not paying attention, not studying hard, or not interested in the subjects. None of students put the blame on their science teachers' teaching. This kind of self-examining attitude were encouraged in the Taiwanese society.. Taiwanese people think success is related to how much diligence people put on the work, instead of relying on other factors outside the individual.

Another phenomena appeared in Taiwan is that in the classroom, only teacher asked questions to students, and then the majority of the students would respond to teachers' questions. Usually questions were asked by teachers instead of students. The purpose of asking questions by teachers are mainly to check students' understanding, few student-teachers discussion were appeared in the class. When we asked students why did they not ask questions in the class, many of them replied that they were concerned about appearing ignorant among their peers or they did not want to impede curriculum progress.. They were afraid of their peers laugh at their "stupid" questions. Thus, if they have questions they would ask after the class individually. Most of students asked questions after classes were favor with the teachers, thus they are satisfy by what teacher's respond to their answer.

However, in Australian classrooms, students would initiate questions in the classroom, during group work and teachers' lecturing, which was a difference among these two countries. Students liked to express their opinions in the class, and teacher respected all the students' responses by saying "good" ,"excellent", etc. Australian teachers seemed to protect students' self-esteem as much as they can. Students did not have much peer pressure in the class, because they did not attend all the classes together, thus they did not know each other as well as Taiwanese students. In general, Australian students do not feel the same type of pressure to perform in front of their peers as do Taiwanese students.

Discussion

Comparing the difference between Taiwanese and Australian students' perceptions of science teachers' knowledge, we find some features of the culture made the difference of the response among these two groups of students.

1. **The size of the physical setting and the materials that teacher and students used in the classroom made the difference between science teachers' teaching in the classroom.**

From researchers' impression "large vs small" are the phenomena we observed in these two countries. In Taiwan we had large size of class (40 students per class) and larger size of the classroom compared with Australian class. Each student has one own desk, and they are arranged in rows. Because of these physical setting which reinforce students to do work by themselves instead of by group discussion. However, in Australia, the classrooms were filled with eight to ten tables, usually two to three students were seated in one table in the class, thus they automatically work together as a group. The class size is smaller than Taiwan, usually about 20 students per each class. This physical setting of the classroom provided more space and opportunities for teachers to interact with each group of students.

The size and content of the physical science textbooks in Taiwan were smaller and thinner than Australian. Thus the content covered in the Taiwanese physical science textbook were more precise which addressed more on the important concepts instead of other relevant information than Australian science textbook. The Taiwanese physical science textbook for each topic begins with an introduction with one to two paragraph, then followed by lab activities description, description of the concepts, and exercises problems. The Australian science textbooks provided more descriptions, pictures, tables, suggestions for future study, and have more information related to daily life events. The precision of the textbook reinforced students rely heavily on teaches' explaining in the classroom instead of reading the textbook by themselves.

The difference between laboratory learning environment verse regular classroom learning environment in Taiwan and Australia. In Australia, science classes were arranged as laboratory setting already, teachers can have lab activities and regular teaching in the same classroom setting. They have more freedom to decide whether they want to have lab, lecture, or the combination of the two in the class. However, in Taiwan, classroom and laboratory are in different setting. Therefore, most science teachers would finish certain part of the content, then waited to use the laboratory. In some case, teachers would carry the equipment from supply room and walked for a certain distance to the class by themselves. This kind of separating setting increase the difficulty and inconvenience of incorporate both laboratory activities and lecture in teaching the nature of science. Thus, most of the laboratory work we observed in Taiwan were based on confirmation of lab results from textbooks. Another difference between physical setting is OHP equipment was arranged in all the Australian science classroom which made teachers used to have OHT in their teaching. However in Taiwan, OHP equipment did permanent arranged in the classroom, thus science teaches concentrated on using blackboard writing in the classroom.

2. **The different expectations of teachers' role in Taiwan and Australia which made science teachers perform differently in the classroom.**

In Taiwan, society puts a high value on education and expects that good teachers could help students attend better schools. Thus, in the class, most of science teachers would take the whole learning responsibility for the students. They organized and presented the content from textbooks for students, constant monitored students' learning by giving quiz, asking questions to reinforce students in mastering their content knowledge.

However, in Australia, the position of teachers in society is much less than in former years even though

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society's expectations of the work of teachers has risen. But these expectations are not necessarily in terms of teaching subject matter of, say, science, but rather of a general attention to improving student behavior or acting in a parental role for an absent parent. Paradoxically, the work of teachers in Australia becomes increasingly difficult at the same time as their status lessens. While teachers are expected to help students perform to the best of their ability, it is recognized that the students have an equal role in their own learning. In addition, Australian society respects each individual. Thus in the classroom, we found teachers pay more respect to individual students' needs, and provided teaching activities for students to be involved on personal level, but they did not push students to master their content knowledge. In many ways, the science learned in junior high school is more concerned with the processes of science than the content.

Conclusion

As we finished this study, we learned how culture—such as physical setting, students' learning habit, the curriculum, and the society's expectation of the teachers influenced students' perceptions of teachers' knowledge in the science classes. There is no good or bad way for each culture's science teaching. But we think, based on this comparison study, that we can suggest Taiwanese science teachers to increase their variety of teaching strategies, assessment methods, and how science and technology related to society and students' life in their future teaching. In addition, giving students more responsibility in reading and in comprehension the textbooks are also important for Taiwanese science teachers.

In Australia, it seems that students have to take more responsibility for their own learning instead of relying heavily on their own teachers. A more casual classroom atmosphere exists in Australia compared with Taiwan. Although this allows for a more friendly relationship between students and their teacher, it also does not allow the teacher to easily admonish the students for off-task behavior. Thus a problem arises as how to motivate students' to be more interested in science learning, and how to help them master the science concepts in order to apply them in future study. One of the potential outcomes of this study is that from observations of Taiwanese classrooms it may be possible to suggest ways of improving student learning in Australian classrooms – and vice versa – based on different perceptions for teachers Representational Repertoire and Knowledge of Students' Understanding.

As science teacher educators in both countries, we think these two countries of science teachers have many teaching features in common. Based on students' perceptions, Teachers' Instructional Strategies were ranked as the lowest category followed by Representational Repertoire, Knowledge of Students' Understanding, and Teachers' Subject Matter Knowledge. These findings indicated that both countries of science teachers showed more emphasis on content teaching and monitoring students' understanding, and less on designing instructional strategies and content representations. However, it is very important for teachers to have the ability in designing and managing their teaching and learning activities, and pay more attention on content representations. Because having these kinds of knowledge could help science teachers to teach science in an more interesting and meaningful way for the students.

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Appendix 1: Students' perceptions toward teachers' knowledge

IR	Almost Never	Seldom	Some-Times	Often	Almost Always
2.My teacher? teaching methods keep me interested in science	1	2	3	4	5
3.My teacher provides opportunities for me to express my point of view	1	2	3	4	5
4.My teacher uses different teaching activities to promote my interest in learning	1	2	3	4	5
5.My teacher uses appropriate models to help me understand science concepts.	1	2	3	4	5
6.My teacher uses interesting methods to teach science topics	1	2	3	4	5
7.My teacher? teaching methods make me think hard	1	2	3	4	5
8.My teacher uses a variety of teaching approaches to teach different topics.	1	2	3	4	5
9.My teacher shows us activities that I can use to continue my study of a topic.	1	2	3	4	5
RR	**Almost Never**	**Seldom**	**Some-Times**	**Often**	**Almost Always**
1.My teacher uses familiar examples to explain scientific concepts	1	2	3	4	5
2.My teacher uses appropriate diagrams and graphs to explain science concepts	1	2	3	4	5
3.My teacher uses demonstrations to show science concepts	1	2	3	4	5
4.My teacher uses real objects to help me understand science concepts	1	2	3	4	5
5.My teacher uses stories to explain science ideas	1	2	3	4	5
6. My teacher uses analogies with which I am familiar to help me understand science concepts.	1	2	3	4	5
7.My teacher uses familiar events to describe scientific concepts	1	2	3	4	5
SMK	**Almost Never**	**Seldom**	**Some-Times**	**Often**	**Almost Always**
1.My teacher knows the content s/he is teaching	1	2	3	4	5
3.My teacher knows how science theories or principles have been developed.	1	2	3	4	5
5.My teacher knows the answers to questions that we ask about science concepts.	1	2	3	4	5
6.My teacher knows how science is related to technology	1	2	3	4	5
7.My teacher knows the history behind science discoveries	1	2	3	4	5
8.My teacher explains the impact of science on society	1	2	3	4	5

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KSU	Almost Never	Seldom	Some-Times	Often	Almost Always
1.My teacher? tests evaluate my understand of a topic	1	2	3	4	5
2.My teacher? questions evaluate my understand of a topic	1	2	3	4	5
3.My teacher? assessment methods evaluate my understanding	1	2	3	4	5
4.My teacher uses different approaches (questions, discussion, etc) to find out whether I understand.	1	2	3	4	5
6.My teacher assesses the extent to which I understand the topic	1	2	3	4	5
7.My teacher uses tests to check that I understand what I have learnt	1	2	3	4	5
8.My teacher? tests allow me to check my understanding of concepts.	1	2	3	4	5

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